

INDOOR AIR QUALITY ASSESSMENT

**South River Elementary School
54 Hatch Street
Marshfield, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
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Background/Introduction

At the request of the Marshfield Public School Department (MPSD) and Principal Ms. Linda Loiselle, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at South River Elementary School (SRES), 54 Hatch Street, Marshfield, Massachusetts. The request was prompted by reports of odors in classroom 210, as well as mold concerns and soot deposition in classroom 109.

On January 4, 2008, the SRES was visited by Cory Holmes and Susan Koszalka, Environmental Analysts in BEH's Indoor Air Quality (IAQ) Program, to conduct an IAQ assessment. BEH staff were accompanied by Principal Loiselle, Jim Davis, Head Custodian and Michael Goodman, Teacher/Building Representative over the course of the assessment.

The SRES is a multi-level red brick building that was constructed in 1950; an addition was built in 1952. The upper level consists of general classrooms, library, reading room, clinic and office space. The lower level is made up of general classrooms, kitchen, cafeteria, boiler room, custodial areas and a teacher's lounge. The basement contains a former auditorium that was converted into an art room and a computer room. New windows were installed over a period of time from 2002 to 2004 and are openable throughout the building. The roof was replaced in 2006. Mr. Davis also reported that mechanical exhaust motors have been replaced over the last several years.

In September of 2006, Huntington Controls, Inc. (Huntington) a heating, ventilation and air conditioning (HVAC) engineering firm, conducted carbon dioxide testing and performed an evaluation of the schools mechanical ventilation system and controls. The Huntington report recommended: 1) repairing air leaks, 2) calibrating thermostats, 3) opening all exhaust louvers,

4) speeding up exhaust fans in rooms with high carbon dioxide levels, and 5) ensuring that all outside air dampers function properly (Huntington, 2006).

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). BEH staff also performed visual inspection of building materials for water damage and/or microbial growth. Water content of porous building materials was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The school houses a student population of approximately 560 and a staff of approximately 75. The tests were taken during normal operations with the exception of first grade classrooms, which were not occupied due to a field trip on the day of the assessment. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in 20 of 25 areas surveyed, indicating adequate ventilation in the majority of the areas

surveyed during the assessment. It is important to note that the assessment occurred on a cold gusty day where temperatures were below freezing ($<32^{\circ}\text{F}$), and fresh/outside air intake is limited to prevent freezing of pipes. At the time of the assessment several areas were empty or sparsely populated, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher with full occupancy.

Fresh air in classrooms is supplied by unit ventilator (univent) systems (Picture 1). A univent draws air from outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and returns air through an air intake located at the base of the unit ([Figure 1](#)). Fresh and return air are mixed, filtered (Picture 3), heated and provided to classrooms through an air diffuser located in the top of the unit. In a number of classrooms, items were seen on and/or in front of univents obstructing airflow (Picture 4). Univents are reportedly original equipment from the 1950's. Univents of this age can be difficult to maintain because replacement parts are often unavailable.

Exhaust vents in the 1950 portion of the building are located in floor level "cubbies" powered by a motor located in a cupola (Pictures 5 and 6). Exhaust vents for the 1952 addition are located on classroom walls (Picture 7). In both cases, the amount of airflow into the exhaust vent can be adjusted by a flue connected to a pull chain (Pictures 5 and 7). Additional exhaust vents in the 1952 classrooms are located in the ceilings of coat closets (Picture 8). Air is drawn into the coat closet from the classroom via undercut closet doors (Picture 9). Many of the exhaust vents were obstructed by various classroom items, limiting airflow (Pictures 10 and 11). In order for univents and exhaust vents to operate as designed, they must remain free of obstructions and be allowed to operate while rooms are occupied.

Exhaust vents in the restrooms were not operating during the assessment and were found backdrafting cold air. As mentioned previously, the assessment occurred on a cold gusty day, which forced air down the exhaust ducts “pressurizing” the restrooms. Exhaust ventilation is necessary in restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The mechanical ventilation systems at the SRES were reportedly balanced in 2005-2006.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is

5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult [Appendix A](#).

Temperature measurements in occupied areas on the day of the assessment ranged from 68° F to 75° F, which were within or close to the lower end of the MDPH recommended comfort range. The temperature in the boy's restroom was measured at 61° F due to backdrafting (as described previously). The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, it is often difficult to control temperature and maintain comfort with equipment of this vintage (> 50 years old).

Indoor relative humidity ranged from 16 to 20 percent, which was below the MDPH recommended comfort range in all areas surveyed during the assessment. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity would be expected to drop below comfort levels during the heating season. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of

the United States.

Microbial/Moisture Concerns

In order for building materials to support mold growth, a source of water exposure is necessary. Identification and elimination of the source of water moistening building materials is necessary to control mold growth. BEH staff, along with Mr. Davis, Principal Loiselle and Mr. Goodman, thoroughly examined building materials and stored items throughout classroom 109 and found no evidence of water damage or visible mold growth.

Several other areas of the building showed evidence of historical water damage and or had potential sources of moisture, which could lead to mold growth. Water stained ceiling tiles were seen in several areas (Picture 12/Table 1). Water-damaged ceiling tiles can provide a source for mold growth and should be replaced after a water leak is discovered and repaired. Active leaks were reported near windows in the computer room/stage area.

Water damaged ceiling plaster and peeling paint was observed in a number of areas including beneath a skylight in the boys restroom (Picture 13); in the teachers lounge, where the source of water penetration appeared to be through a passive attic vent directly on the exterior of the building (Picture 14); and in several exterior classrooms near windows, which appears to be historic damage prior to windows being replaced in 2002-2004. A consistent staining pattern was also observed in classroom 115 along the ceiling above pipes (Pictures 15 and 16). BEH staff conducted moisture testing to determine if the material was wet. Materials with increased moisture content *over normal* concentrations may indicate the possible presence of mold growth. The stained ceiling plaster tested during the assessment was found to have low (i.e., normal)

moisture content. Moisture content of materials measured is a real-time measurement of the conditions present at the time of the assessment.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. Plants should be equipped with drip pans; the lack of drip pans can lead to water pooling (Picture 17) and mold growth on windowsills. Plants are also a source of pollen. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom. An indoor planter was observed in classroom 208. No source of drainage could be identified for this planter (Picture 18).

Open seams between sink countertops and walls were observed in several rooms (Picture 19/Table 1). If not watertight, water can penetrate through the seam, causing water damage. Improper drainage or sink overflow can lead to water penetration into the countertop, cabinet interior and areas behind cabinets. Water penetration and chronic exposure of porous and wood-based materials can cause these materials to swell and show signs of water damage. Many classrooms were also found to have porous materials (e.g., cardboard, paper, cloth) stored beneath sinks (Picture 20), which is a humid environment. Repeated moistening of porous materials can result in mold growth.

BEH staff examined the exterior of the building to identify breaches in the building envelope that could provide a source of water penetration. Several potential sources were identified such as damaged brickwork and missing/damaged mortar around masonry (Pictures 21 through 24) and open utility holes (Picture 25). These conditions can undermine the integrity of the building envelope and provide a means of water entry by capillary action into the building

through exterior walls, foundation concrete and masonry (Lstiburek & Brennan, 2001). In addition, they can serve as pathways for insects, rodents and other pests into the building.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Odor Investigation

As reported by Principal Loiselle and Mr. Davis, an odor in classroom 210 was detected in the summer of 2007 following the application of a particular brand of Sherwin-Williams paint to a portion of the ceiling. MDPH had encountered similar reports of odors from Sherwin-Williams interior primers and paints. MDPH made inquiries to the Sherwin-Williams Company, who acknowledged that they had received similar odor complaints. As a result of the MDPH inquiry, Sherwin-Williams Company offered assistance to individuals experiencing this odor problem (SWC, 2002). At the time of this assessment, the MPSD had not contacted Sherwin-Williams Company for assistance.

Attempts to mitigate odors were reportedly made by using a commercial grade sealant. However, lingering odors still persist. A slight odor was detected by BEH staff in room 210 at the time of the assessment. Mr. Davis and Ms. Loiselle reported that the odor is stronger at the beginning of the week, particularly in the morning. This condition would likely be related to the school's mechanical ventilation system being deactivated and windows being shut over the weekend.

Indoor air quality can be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether measurable levels of VOCs were present in the building, and particular in classroom 210, air monitoring for TVOCs was conducted. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND (Table 1). Although slight odors were detected in classroom 210, TVOC concentrations were ND in this room as well as in other areas throughout the building during the assessment (Table 1). In subsequent correspondence with Principal Loiselle, it was recommended that the MPSD contact the paint manufacturer (Sherwin-Williams Company) to discuss further mitigation to reduce/eliminate odors.

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. In an effort to identify materials that can potentially increase indoor TVOC concentrations, BEH staff examined classrooms for products containing these respiratory irritants. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat. Cleaning products were also found on countertops and in unlocked cabinets beneath sinks in some classrooms (Picture 20). Like dry erase materials, cleaning

products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

Soot Deposition in Classroom 109

As reported by Principal Loiselle and Mr. Davis, black soot-like deposition was found on flat surfaces in classroom 109 in September 2006. Mr. Davis attributed the presence of the material to the start up of the boiler system; the material was cleaned and reportedly has not reoccurred. Although the start up of the boiler plant for the heating season may be the most likely source of the material, the configuration/location of the room may also contribute to accumulation of dirt, dust and debris. BEH staff examined the room and its relationship to the exterior of the building. This classroom is located at the terminus of an alcove where two wings intersect outside the building (Picture 26). Loose dirt and plant debris was observed below and had accumulated on the univent fresh air intake outside the building (Picture 27). BEH staff opened the univent cabinet to examine the interior and found similar accumulations of dirt and debris inside. It is likely that dirt dust/debris accumulates in this area due to the configuration of the outside of the building, an alcove that can trap air currents and stir up loose dirt/debris, which can then be drawn into the classroom via the univent.

Another possible source relates to the radiator vents along the exterior wall/window system (Picture 28). During spring/summer common household dirt, dust and debris can settle into these vents. When the heating system is activated small particulates can become airborne as heat rises from the vents, providing a source of irritation.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants.

Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM_{2.5}) can produce immediate and acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEH staff obtained measurements for carbon monoxide and PM_{2.5}.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. An operator of an indoor ice must take actions to reduce carbon monoxide levels, if those levels exceed 30 ppm, 20 minutes after resurfacing within a rink (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State

Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it is present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). Carbon monoxide levels measured in the school were also ND during the assessment.

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM₁₀). According to the NAAQS, PM₁₀ levels should not exceed 150 microgram per cubic meter ($\mu\text{g}/\text{m}^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM_{2.5} standard requires outdoor air particle levels be maintained below 35 $\mu\text{g}/\text{m}^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM₁₀ standard for evaluating air quality, MDPH uses the more protective PM_{2.5} standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM_{2.5} concentrations the day of the assessment were measured at 19 $\mu\text{g}/\text{m}^3$. PM_{2.5} levels measured in the school ranged from 15 to 22 $\mu\text{g}/\text{m}^3$ (Table 1), which were below the NAAQS PM_{2.5} level of 35 $\mu\text{g}/\text{m}^3$. Frequently, indoor air levels of particulates (including PM_{2.5}) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the

operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

In a few classrooms, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

A number of personal fans and exhaust/return vents were observed to have accumulated dust (Pictures 29 and 30). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles. Re-activated fans can also aerosolize dust accumulated on vents/fan blades. Open utility holes were observed in ceilings and walls in rooms 206 and 209, which can serve as pathways for drafts, dust and debris that accumulates in the ceiling plenum/wall spaces into occupied areas (Pictures 31 and 32).

Finally, a number of classrooms contained upholstered furniture and pillows (Pictures 33 and 34). These items are covered with fabric that comes in contact with human skin, which can leave oils, perspiration, hair and skin cells. Dust mites feed upon human skin cells and excrete waste products that contain allergens. Furthermore, increased relative humidity levels above 60 percent can also perpetuate dust mite proliferation (US EPA, 1992). In order to remove dust mites and other pollutants, frequent vacuuming of upholstered furniture is recommended (Berry, 1994). It is also recommended that if upholstered furniture is present in schools, it should be

professionally cleaned on an annual basis or every six months if dusty conditions exist (IICRC, 2000).

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Continue with plans to contact the Sherwin-Williams Company to discuss further mitigation actions to reduce/eliminate odors. According to Sherwin Williams, customers experiencing the reported odors may contact them at their toll free number, (800) 547-2450, for assistance. Remediation of the odor may include stripping of the paint or repainting with an appropriate material.
2. In the interim, continue to operate both supply and exhaust ventilation continuously during periods of school occupancy, independent of classroom thermostat control to maximize air exchange.
3. Remove all blockages from univents and exhaust vents/cubbies to facilitate airflow.
4. Use openable windows in conjunction with classroom univents and exhaust vents to increase air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
5. Close classroom doors to maximize air exchange.
6. Restore exhaust ventilation in restrooms to remove odors and moisture, make repairs as necessary.
7. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).

8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
9. Ensure leaks are repaired (e.g., computer room/stage area). Remove/replace water damaged ceiling tiles. Examine the areas above and around for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
10. Examine passive vent to attic (Picture 14) and skylight in boy's restroom; take measures to prevent water infiltration.
11. After leaks are repaired, make repairs to water damaged wall and ceiling plaster.
12. Contact a masonry firm or general contractor to repair holes/breaches in exterior walls to prevent water penetration, drafts and pest entry.
13. Move plants away from univents in classrooms. Avoid over-watering and examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.
14. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect wallboard for water damage and mold growth, repair/replace as necessary. Disinfect areas with an appropriate antimicrobial, as needed. Consider replacing with single piece molded countertops as shown in Picture 35.

15. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
16. Clean personal fans, univent air diffusers, return vents and exhaust vents periodically of accumulated dust. Particular attention should be paid in classroom 109.
17. Inspect exterior fresh air intakes for univents periodically, clean as needed. Particular attention should be paid in classroom 109.
18. Seal open utility holes in walls and ceilings to prevent migration of drafts and particulates into occupied areas.
19. Store cleaning products properly and out of reach of students.
20. Clean upholstered furniture and pillows on the schedule recommended in this report. If not possible/practical, consider removal from classrooms.
21. For more advice on mold please consult the document “Mold Remediation in Schools and Commercial Buildings” published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html.
22. Consider adopting the US EPA (2000) document, “Tools for Schools”, as an instrument for maintaining a good indoor air quality environment in the building. This document is available at: <http://www.epa.gov/iaq/schools/index.html>.
23. Refer to resource manual and other related indoor air quality documents located on the MDPH’s website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: <http://www.state.ma.us/dph/MDPH/iaq/iaqhome.htm>.

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Picture 1



Original 1950s Vintage Univent

Picture 2



Univent Fresh Air Intake

Picture 3



Set of Two Pleated Filters in Classroom Univents

Picture 4



Classroom Furniture and Items Obstructing Univent (Exterior Wall) Airflow

Picture 5



Exhaust Cubby with Pull Chain in Original 1950 Portion of Building

Picture 6



Cupola Containing Exhaust Motor for Exhaust Vents in Original 1950 Portion of the Building

Picture 7



**Wall-Mounted Exhaust Vent with Pull Chain (Arrow) in 1952 Addition,
Suspended Paper Indicates Draw**

Picture 8



Exhaust Vent in Ceiling of Coat Closet, Note Stored Materials

Picture 9



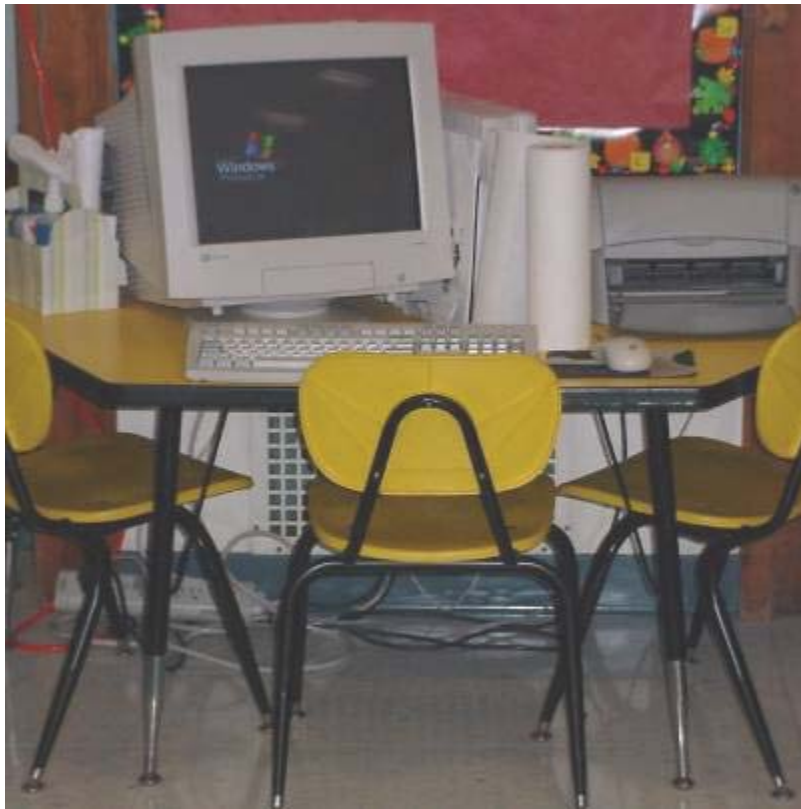
Swinging Doors to Coat Closet Exhaust in 1952 Portion of Building

Picture 10



Partially Obstructed Exhaust Vent

Picture 11



Partially Obstructed Exhaust Vent

Picture 12



Water Damaged Ceiling Tile

Picture 13



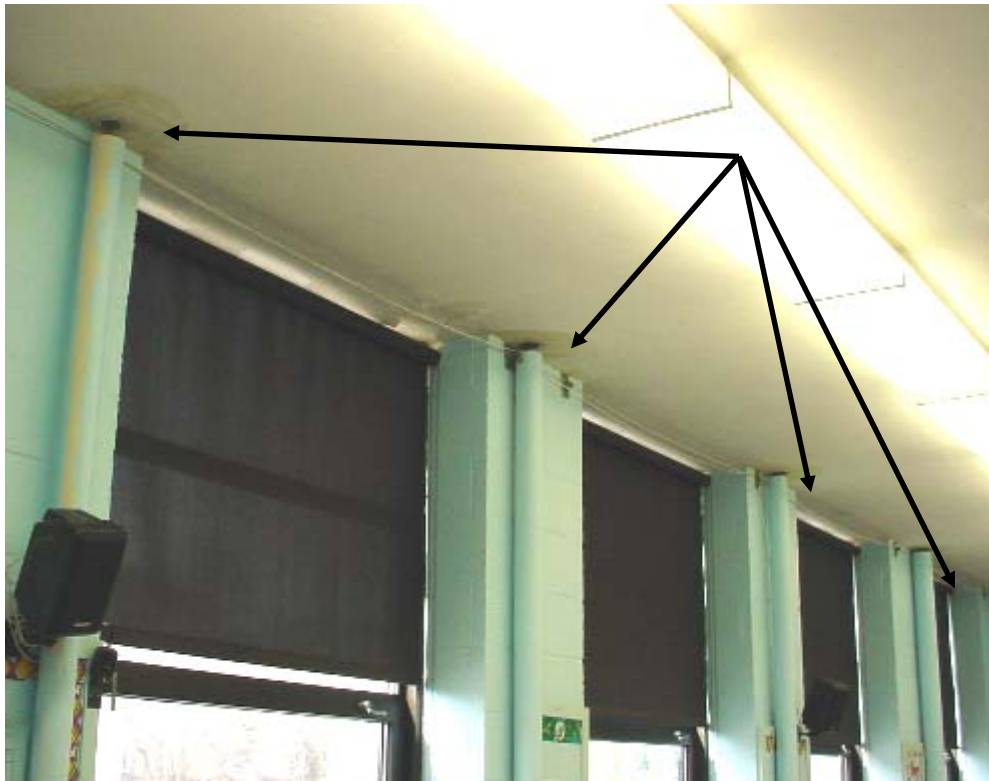
Water Damaged Wall/Ceiling Plaster in Boys Restroom under Skylight

Picture 14



Exterior Passive Attic Vent Opposite Interior Water Damaged Ceiling Plaster in Teacher's Workroom

Picture 15



Patterned Staining of Ceiling Plaster near Pipes in Classroom 115

Picture 16



Close-Up of Water Damaged Plaster (Left) and Stained Plaster around Pipe (Right) Classroom 115

Picture 17



Moistened Wooden Windowsill beneath Plant in Stage Area

Picture 18



Indoor Planter in Classroom 208

Picture 19



Spaces between Classroom Sink Countertop and Backsplash

Picture 20



Porous Materials, Cleaners and Spray Paint underneath Sink in Unlocked Cabinet

Picture 21



Missing/Damaged Mortar around Brick

Picture 22



Missing/Damaged Mortar/Brick

Picture 23



Missing/Damaged Mortar around Brick along 2nd Floor Window Frame

Picture 24



Cracked/Damaged Exterior Brick along Rear of Building

Picture 25



Open Utility Hole and Cracked Brickwork

Picture 26



Corner of Building Where Room 109 is Located, Note Location of Intake Vent

Picture 27



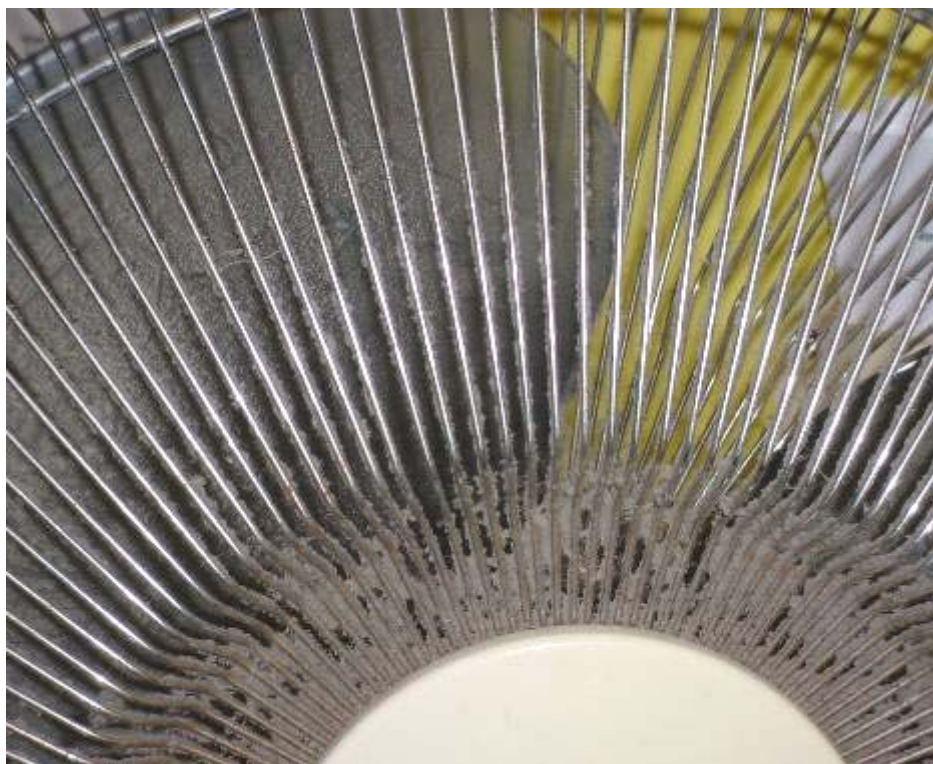
Univent Fresh Air Intake, Note Debris in Bottom of Intake

Picture 28



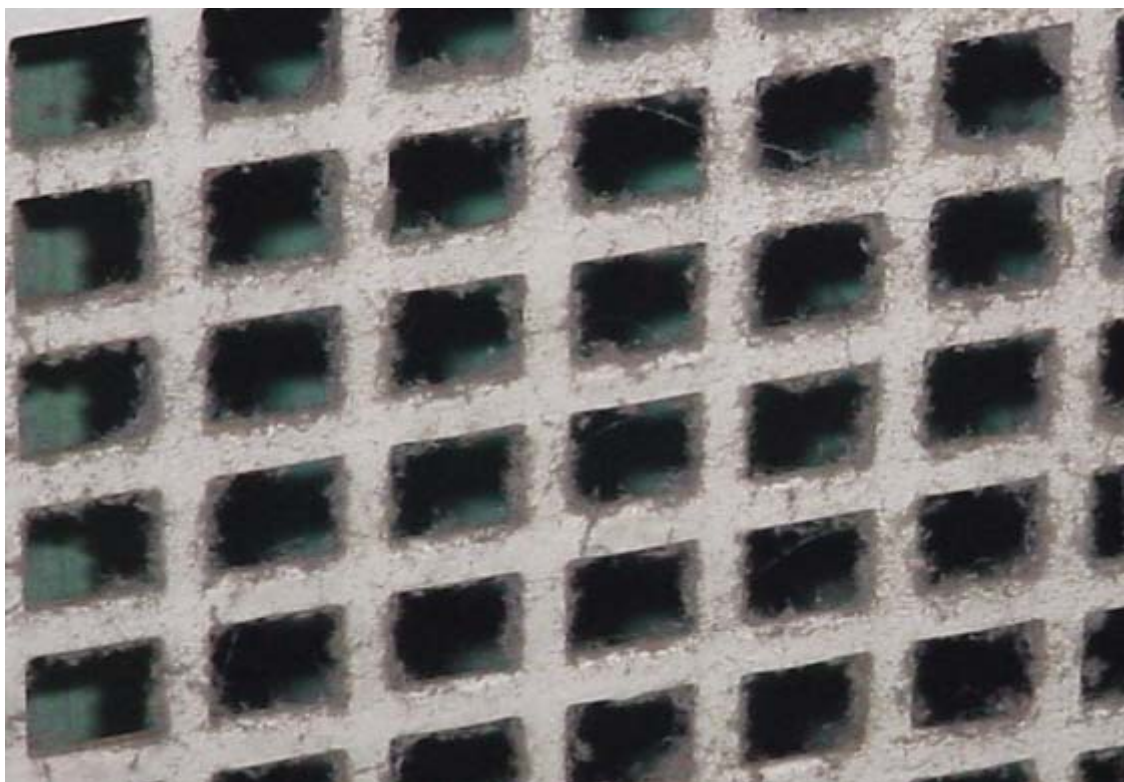
Radiator Vents along Exterior Wall/Window of Classroom 109

Picture 29



Accumulated Dust/Debris on Classroom Fan

Picture 30



Accumulated Dust on Exhaust Grill

Picture 31



Open Utility Hole in Classroom Ceiling 206

Picture 32



Open Utility Holes in Classroom Wall

Picture 33



Pillows in Classroom, Note Damaged Pillow with Stuffing on Floor

Picture 34



Stained Furniture Cushion in Classroom

Picture 35



Molded One-Piece Sink Countertop

Location: South River Elementary School
Address: 54 Hatch Street, Marshfield, MA

Indoor Air Results
Date: 1/4/2008

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background	N/A	<32	33	323	ND	ND	19				7°F winds SW 3-15, gusts up to 25 mph, scattered clouds
Art Room	18	69	20	680	ND	ND	18	Y	Y	Y	Art room occupies a section of the Auditorium
Computer Room	0	71	19	580	ND	ND	17	Y	N	N	Door openable to outside, gaps in door, DEM, plants on window sill, liquid in beakers, unlabeled (catching water leaks).
102	19 occ gone for ~ 20 minutes	70	19	764	ND	ND	19	Y	Y	Y	Clutter observed. Univent partially blocked; exhaust blocked, DEM
Girls' Bathroom	0	69	17	478	ND	ND	16	Y	Y Passive door vent	Y	Floor drain noted. Exhaust dusty and backdrafting
101	0	69	17	475	ND	ND	17	Y	Y	Y	Exhaust located in coat closets. Clutter on Univent and throughout classroom. DEM. Plants near radiator. Furniture and cushions noted. Chemicals stored under sink, not locked.

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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: South River Elementary School

Address: 54 Hatch Street, Marshfield, MA

Indoor Air Results

Date: 1/4/2008

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Boys' Bathroom	0	61	17	463	ND	ND	21	N-skylight	Y Passive door vent	Y	Exhaust weak. Leak from skylight, peeling paint.
109	0	68	16	680	ND	ND	18	Y	Y	Y	Radiator dusty, debris surrounding air intake outside, chemicals under sink. DEM.
104	0	75	16	534	ND	ND	17	Y	Y	Y	Flat roof above, replaced and sealed in 2006 due to leak. DEM.

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									Supply	Exhaust	
106	18	74	17	646	ND	ND	19	Y	Y	Y	Exhaust partially blocked, dusty. Chemicals on and under sink, musty odor under sink. Spaces along sink backsplash, Univent partially blocked plastic containers on Univent. Exhaust in coat closets was weak. DEM.
111	24	72	17	810	ND	ND	19	Y	Y	Y	Plants near Univent, One window open. Chemicals under sink. Historic ceiling water damage. DEM.
113	22	74	19	1060	ND	ND	22	Y	Y	Y	Univent cluttered, chemicals under sink. PF-dusty. DEM.

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									Supply	Exhaust	
115	22	76	19	1058	ND	ND	19	Y	Y	Y	HEPA filtration unit operating. Chemicals under sink. Ceiling discoloration where pipes (4) meet ceiling. Delmhorst Moisture Detector inserted-low (i.e., normal) moisture. DEM.
208	0	73	16	670	ND	ND	17	Y	Y	Y	Indoor planter at window with soil. Chemicals on sink. Empty plastic juice bottles. Ceiling repair. Furniture noted. DEM.
210 (odor complaint)	0	72	17	622	ND	ND	15	Y	Y	Y	Slight odor detected in front of classroom. Chemicals under sink, DEM.
210 (reassessed when students present)	15	77	19	981	ND	ND	15	Y	Y	Y	Rust along sink backsplash. HEPA filtration system present but shut off. Moisture measurement ceiling plaster-low/normal, plastic containers on Univent-dusty.

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									Supply	Exhaust	
206	24	69	19	712	ND	ND	18	Y	Y	Y	Door open, plants near Univent. Univent partially blocked. Historic ceiling water damage. PF-dusty. Chemicals under sink. Utility hole in ceiling. DEM + chalk blackboard.
209	21	69	17	770	ND	ND	22	Y	Y	Y	Pillows on floor. DEM. Univent cluttered. Soil in pot near Univent. PF-dusty. Utility holes in wall. Sink drain clogged. Historic ceiling water damage.

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									Supply	Exhaust	
Work Room	1	71	19	705	ND	ND	16	N	Door Vent	Y	Copy machines. Exhaust vent dusty.
201	23	72	18	760	ND	ND	17	Y	Y	Y	Univent cluttered. Ceiling repair. Clean fish tank w/fish. Chemicals, paper and plastic bags under sink. DEM.
109 reassessment	30	72	19	1140	ND	ND	17	Y	Y	Y	Reassessed. Breach in ceiling, no evidence of water damage/mold growth.

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